The Effect of Thermal Fluctuations on the Measured Detector Signal of Planck HFI

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A summary is presented of work done to model the thermal fluctuations of the Planck High Frequency Instrument (HFI) and the effect of these fluctuations on the measured detector signal of the instrument. HFI bolometric detectors must operate at 0.1 K, with their performance highly dependent on both absolute temperature and temperature stability. To achieve this, a cryogenic cooling chain is implemented incorporating active and passive elements, with each stage dependent on the previous one. The spacecraft provides passive cooling to 60 K using a series of radiators, which thermally decouple the payload from the warm service module. A sorption refrigerator cools the HFI precooling stage and the Low Frequency Instrument to 20 K and a Joule-Thomson cooler then cools the HFI to 4 K. Cooling to 0.1 K is achieved using a dilution refrigerator, with an intermediate 1.6 K stage providing radiative and conductive decoupling from the 4 K stage. The complex interactions between instruments, coolers and spacecraft mean end-to-end modeling is critical. Geometrical models of the instruments have been constructed by instrument groups and integrated with a spacecraft model to calculate radiative couplings. These have been incorporated into a detailed thermal mathematical model of the spacecraft, instruments and coolers to produce a Global Thermal Model (GTM). To provide a link between the GTM and the production of Time Ordered Data of the measured signal, a Radiative Thermal Transfer Model (RTTM) has been created to model the effect of thermal fluctuations on detector output. Using simulated sky data, outputs from the GTM have been linked to the RTTM to produce prototype data streams. These will be passed on to Planck Data Processing teams who are developing algorithms to remove the effects of the thermal fluctuations from the measured sky signal. A summary of the Global Thermal Model is shown, and an overview of the Radiative Thermal Transfer Modeling.

From Spitzer to Herschel and Beyond Pasadena, California, June 2004 Conference Program and Abstracts